A NEW STANDARD FOR URANIUM METAL INTENDED FOR RESEARCH REACTOR FUEL FABRICATION

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ABSTRACT

After many years of recommendation by NUKEM the ASTM Subcommittee C 26.02 has established a draft standard for uranium metal 15 - 20% enriched in U-235 to be used in research reactors. The standard applies to both unirradiated (Enriched Commercial Grade Uranium Metal) and reprocessed uranium (Enriched Recovered Uranium Metal).

The standard unifies both materials, unirradiated and recovered to be referred as “Commercial Grade Enriched Uranium Metal” within the same specification. No distinction is made – not even for transuranic element and fission product contents. For both materials the same limits apply.

For radionuclides, the standard establishes a common specification table of U-isotopes for both, unirradiated and recovered uranium. Although it is considered that unirradiated uranium has much lower contents of the U-isotopes U-232, 234, 236, the specification deals with the same specification values as an envelope for both.

For impurities only 21 individual elements were specified. A maximum limit for the total of impurities and a boron equivalent content (EBC) for limitation of the most sensitive neutron absorbing elements completes the short list of impurity requirements.

The simplification in the draft standard being made by the ASTM is a great progress for buyers and sellers of uranium for research reactors, making uranium procurement a little bit more easy.

INTRODUCTION

For many years, NUKEM recommended at the RERTR meetings that the research reactor community should agree upon one unified standard for low enriched uranium (LEU) in form of metal. A start was made in 1990 in Newport and continued during the Paris meeting in 1995. Recently during the meeting in Seoul 1997 we made more precise proposals for such a standard specification. The idea was always to establish one standard instead of using various specifications, all subject to negotiations between research reactor operator and seller. Finally the ASTM Subcommittee C 26.02 started to prepare such a standard for uranium metal to be used for fuel element production suitable for research reactors. The research reactor community now has the opportunity to discuss this draft in its latest version dated July 27, 1998, the date of the latest ASTM Subcommittee meeting. We are pleased to report to the audience of the research reactor community on the principles of draft #5 of this standard, the proposed limits as well as to comment on this draft from our point of view.

NEW DRAFT ASTM STANDARD

1. DEFINITIONS (see table 1)

The ASTM draft applies to both, unirradiated uranium metal and uranium in any form stemming from reprocessing. The specification defines research reactor uranium as follows: ”Commercial Grade Enriched Uranium Metal” derived from Commercial Natural Uranium, Recovered Uranium or uranium obtained from blending of Highly Enriched Uranium (HEU) with Commercial Natural Uranium, Recovered Uranium or Depleted Uranium.

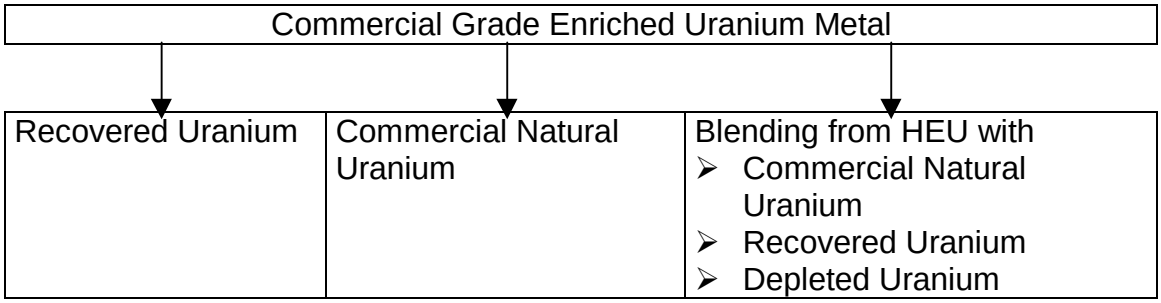

Table 1: Definitions of Uranium Metal

Recovered Uranium is defined as any form of uranium that has been exposed in a neutron irradiation facility with or without chemically separation to be used for fuel fabrication due to low irradiation levels. Burnup levels of spent research reactor fuel are defined to be typically 50% of the original fissile material.

During the last committee meeting the ASTM changed from the double tracked layout of the specification with separate values for the isotopical composition of unirradiated and recovered uranium to a dual use specification unifying the different value tables into one, valid for both materials – for Commercial Grade Enriched Uranium Metal.

We appreciate that finally NUKEM's proposal made at the RERTR in Seoul to use only one specification under the envelope "Commercial Grade Enriched Uranium Metal was accepted.

Furthermore the specification reflects now the requirements for recovered uranium obtained from spent research reactor fuel with burnup levels up to 50% (instead of only 20% as proposed in the previous drafts).

2. ACTIVITY OF THE URANIUM

Although the activity of fission products and transuranic elements for unirradiated uranium are expected to be below the detectable limits, the standard defines the same limits as for recovered uranium. The limits given for the Commercial Grade Enriched Uranium Metal are 600 Bq/gU (γ) for fission products and 500 Bq/g (α) for transuranic elements (Plutonium, Neptunium).

From our point of view the proposed limits are acceptable for Recovered Uranium, the limits take into account health physics requirements as well as the need for recycling of spent fuel in the research reactor market.

3. Uranium isotopes (see table 2)

Even the U-isotopes are specified for both, unirradiated and recovered uranium with the same values:

U-isotope	Value (µg/gU)
U-232	0.002 (µg/gU)
U-234	0.01 g/gU
U-236	0.04 g/gU

Table 2: U-isotope limits

The former draft standard had scheduled 2.5 – 5 times more restrictive values for the uranium isotopes in unirradiated uranium. Now, in order to get one unified standard, the same values as for recovered uranium apply to unirradiated uranium. The result is, that unirradiated uranium is specified with 2ppb U-232, 1% U-234 and 4% U-236. The high U-236 limit is specially remarkable, considering that fresh uranium should not contain any U-236 due to the fact that U-236 is not a natural isotope of uranium.

But this is the tribute to be paid to a unified specification for research reactor uranium metal.
Another improvement to the draft standard was made during the last ASTM meeting: The scheduled Tc-99 analysis was deleted without substitute because no manufacturer made Tc-99 measurements routinely so far.

4. IMPURITIES **(see table 3)**

Draft #3 of the standard contained 29 different impurities to be measured and to be reported. Now, in draft #5, fortunately the number of elements could be reduced to 21. Elements as Hydrogen, Nitrogen and Oxygen, unnecessary to be measured in U-metal have been deleted. Neutron absorbing elements such as Boron, Cadmium, Gadolinium and other rare earths were drawn out of the table of individual impurities and summarized in a boron equivalent factor (EBC). The EBC shall not exceed 4 µg/gU and refers to as the total of all individual EBC values (including B, Gd, Cd).

It goes without saying that the following table applies to both, unirradiated and recovered uranium.

Element	Value (µg/gU)	Element	Value (µg/gU)
Al	150	Mn	25
Be	10	Mo	100
C	550	Ni	100
Ca	100	P	100
Cr	50	Si	100
Co	5	Na	25
Cu	50	Sn	100
Fe	250	Va	10
Pb	10	W	100
Li	10	Zr	250
Mg	50	Total	1500

Table 3: Impurities

Additionally to the table of individual elements to be analyzed the ASTM considered a total of 1500 µg/gU for all impurities to close the gap to the undetected impurities.

We have 3 general remarks to this proposal:

- *It's a good thing to have a limitation of 1500 µg/gU for the total of impurities as a measure to reduce the number of elements to be analyzed.*

- *Furthermore we appreciate the revision of the draft standard by adding a max. boron equivalent (EBC) to the list in order to acknowledge the elements with high neutron absorption cross sections.*

- *The limits for a number of elements have now been raised in such a way that we think that all manufacturers and their clients should now be able to cope with it.*

SUMMARY AND CONCLUSION

The ASTM C 26-02 sub-committee has made its best effort to create a unified standard for research reactor uranium metal as requested by the research reactor community for the last several years. The latest draft #5 is by far more easy to manage than the previous ones.

To be able to refer to such ASTM standard would make life easier for all of us.

Nevertheless the standard is not yet approved.

Now it is the right time to discuss the existing draft standard in order to enable the ASTM subcommittee to revise it once more and to come to a final draft very soon. We like to invite you now to make your comments to the existing draft standard. If you give us your comments now or during this meeting we'll forward them to the ASTM subcommittee in order to discuss it during the next committee meeting. You can be sure that NUKEM Nuklear cares for your interest in the fuel cycle, in the future as in the past.